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(54) **ACCUMULATOR**

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***F16L 55/04*** (2006.01)
***F15B 1/10*** (2006.01)

(52) **U.S. Cl.**
CPC .............. ***F15B 1/103*** (2013.01); ***F15B 1/106*** (2013.01); *F15B 2201/205* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .... F15B 1/103; F15B 1/106; F15B 2201/205; F15B 2201/3151; F15B 2201/3155; F15B 2201/3158; F16L 55/04
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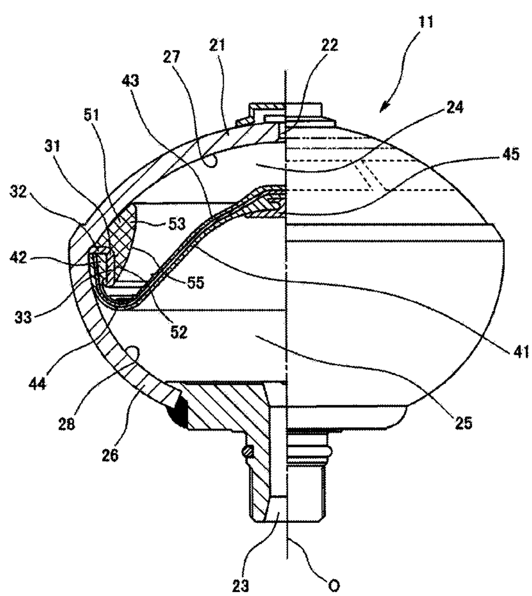
(57) **ABSTRACT**

A diaphragm accumulator provided with a flexible diaphragm inside an accumulator housing has a stress relaxing member having a contact surface which the diaphragm deformed by a pressure fluctuation inside the accumulator housing contacts and regulating the deformed attitude of the diaphragm by the contact surface on the inner surface. When the diaphragm is deformed by the pressure fluctuation inside the accumulator housing, the stress relaxing member regulates the deformed attitude of the diaphragm to reduce a stress generated in the diaphragm.

**2 Claims, 6 Drawing Sheets**



(52) **U.S. Cl.**
CPC ................ *F15B 2201/3151* (2013.01); *F15B 2201/3155* (2013.01); *F15B 2201/3158* (2013.01)

(58) **Field of Classification Search**
USPC ........................................................ 138/30
See application file for complete search history.

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*FIG. 1*

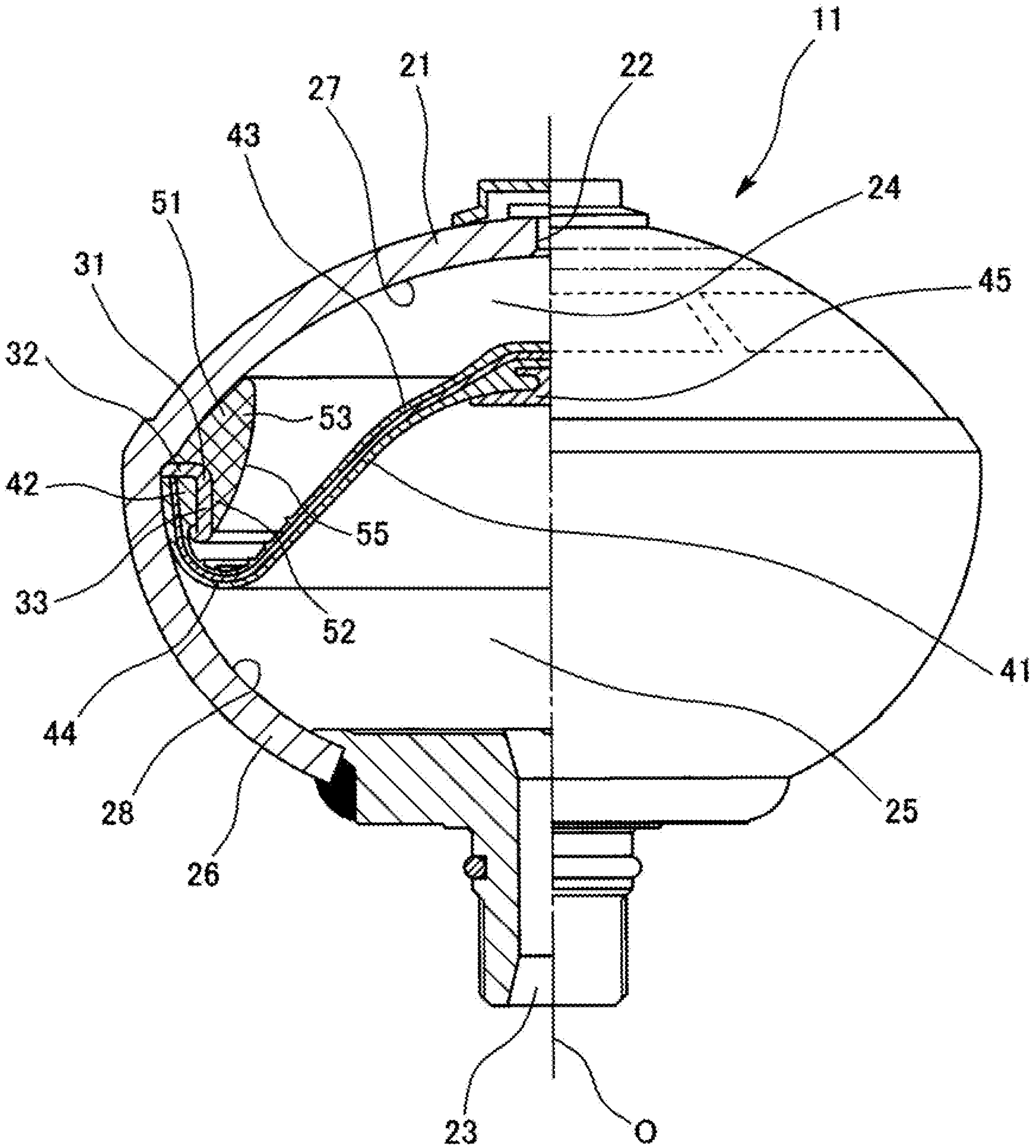


*FIG. 2*

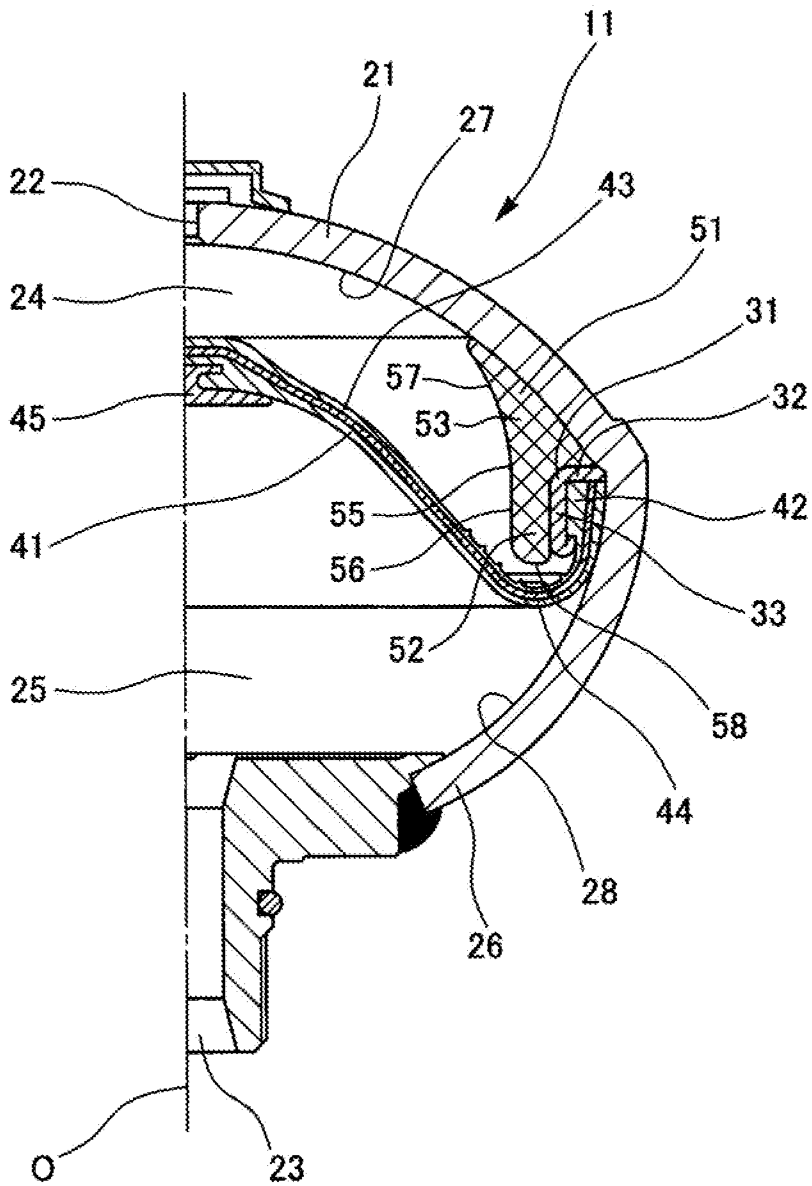


*FIG. 3*
***Background Art***

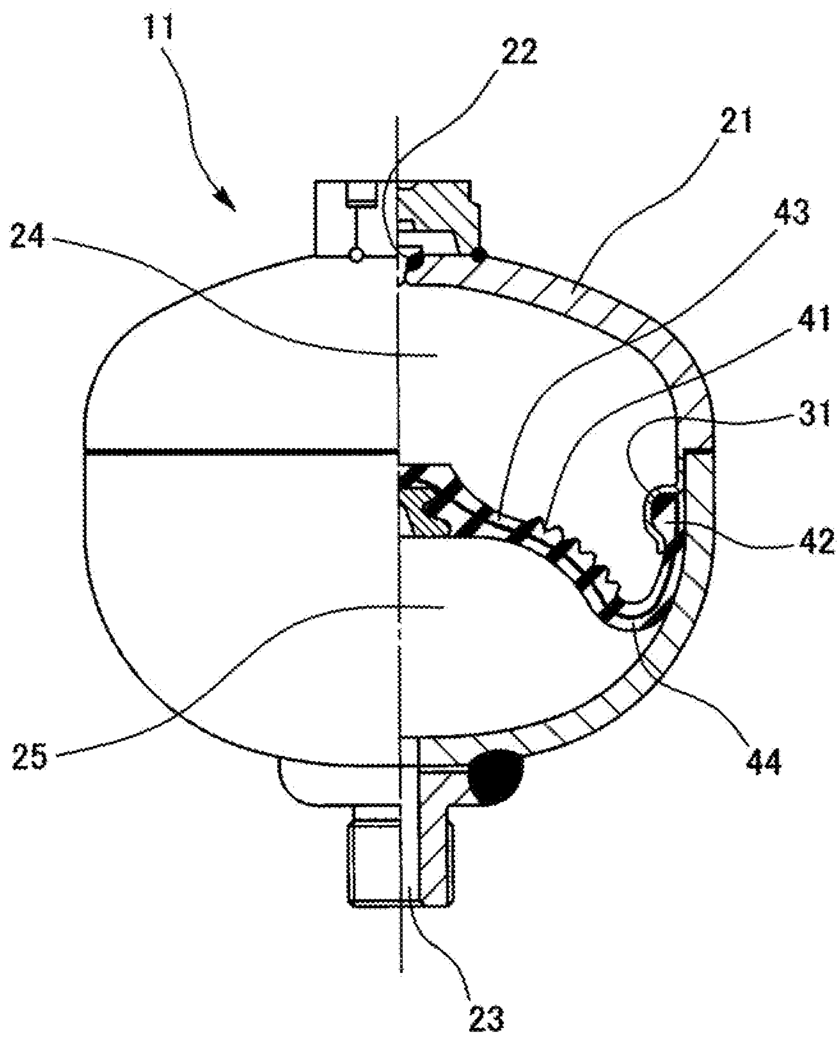


*FIG. 4*

*Background Art*

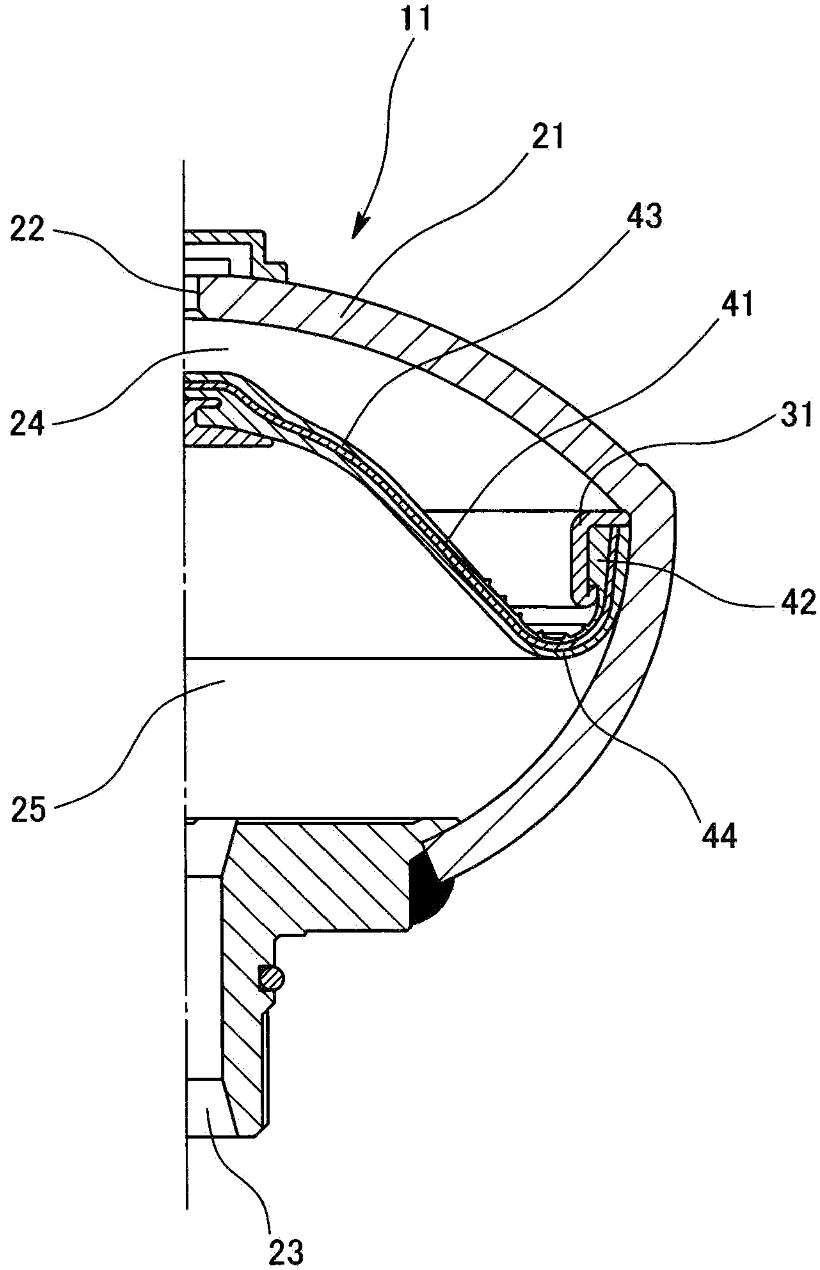


*FIG. 5A*
*Background Art*

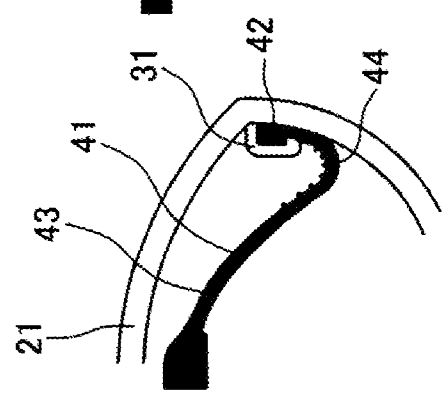



*FIG. 5B*
*Background Art*

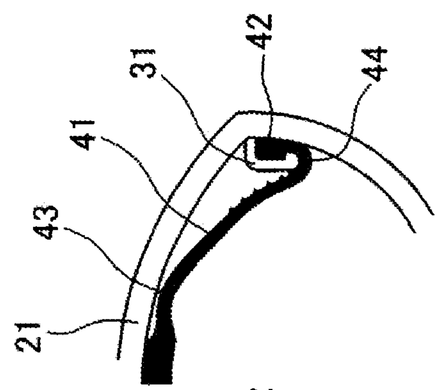



*FIG. 5C*
*Background Art*

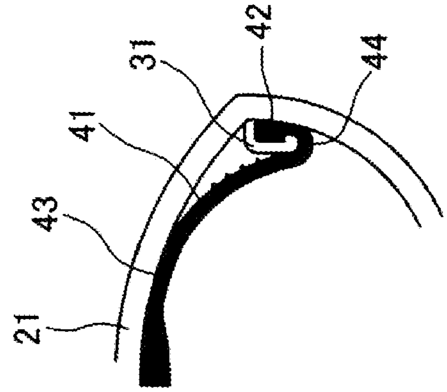



*FIG. 5D*
*Background Art*

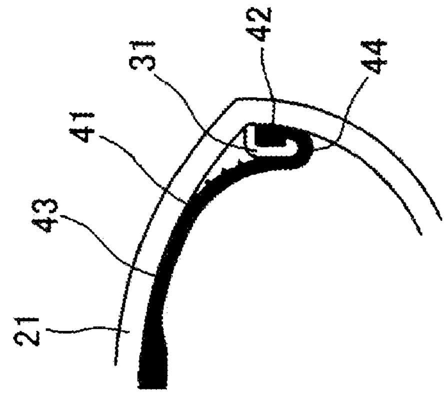
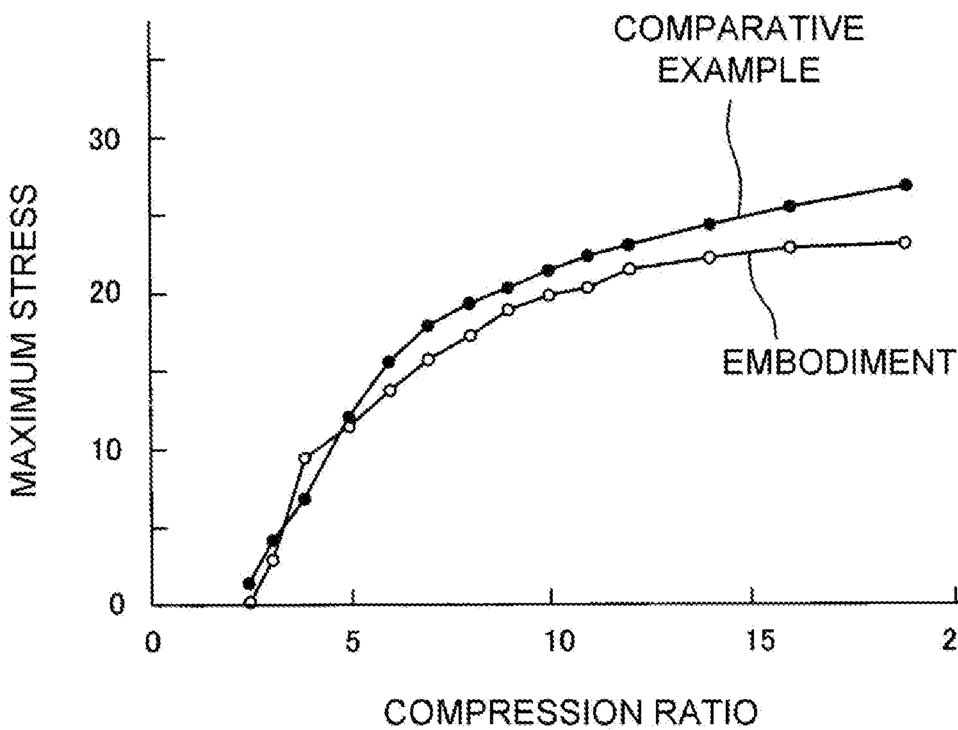


*FIG. 6*


COMPARATIVE
EXAMPLE
EMBODIMENT
MAXIMUM STRESS
30
20
10
0
0
5
10
15
20
COMPRESSION RATIO

# ACCUMULATOR

## CROSS REFERENCE TO RELATED APPLICATIONS

This application is a U.S. National Phase application of International Application No. PCT/JP2018/024370, filed on Jun. 27, 2018 and published in Japanese as WO 2019/004284 A1 on Jan. 3, 2019 and claims priority to Japanese Patent Application No. 2017-126983, filed on Jun. 29, 2017. The entire disclosures of the above applications are expressly incorporated by reference herein.

## BACKGROUND

### Technical Field

The present invention relates to an accumulator and more specifically relates to a diaphragm accumulator provided with a flexible diaphragm inside an accumulator housing. The accumulator of the present invention is used as an on-board accumulator for automobiles, for example.

### Related Art

Conventionally, a diaphragm accumulator **11** is known which has an accumulator housing **21** provided with a gas filling opening **22** and an oil port **23**, in which a diaphragm **41** having flexibility is provided inside the accumulator housing **21** in such a manner as to divide the internal space of the accumulator housing **21** into a gas filled chamber **24** and a fluid chamber **25** as illustrated in FIG. **3**. The gas filled chamber **24** leads to the gas filling opening **22**. The fluid chamber **25** leads to the oil port **23**.

The diaphragm **41** is a resin or rubber laminated structure integrally having an outer peripheral attachment portion **42**, a flexible portion **43**, and a reversing portion **44**. The outer peripheral attachment portion **42** is held by a diaphragm holder **31** provided on the side inner surface of the accumulator housing **21**. The flexible portion **43** is deformed according to a pressure fluctuation inside the accumulator housing **21**. The reversing portion **44** is provided between the outer peripheral attachment portion **42** and the flexible portion **43** and integrally has a reversing portion having a substantially U-shaped cross-section deformed with the flexible portion **43**.

The above-described accumulator **11** has room for further improvement in the following respects.

In the above-described accumulator **11**, when a pressure fluctuation occurs inside the accumulator housing **21**, the diaphragm **41** is deformed towards a pressure equilibrium point accompanying the pressure fluctuation. When an operation compression ratio (=Operation pressure/Filling gas pressure) increases at this time, the flexible portion **43** of the diaphragm **41** is greatly displaced to the gas filled chamber **24** side, so that the reversing degree of the reversing portion **44** increases, whereby the reversing portion **44** is pressed against the inner peripheral surface of the diaphragm holder **31**. This causes the generation of an overstress in the reversing portion **44**. The repetition thereof leads to a breakage of the diaphragm **41** in some cases.

For example, in the accumulator **11** of the Comparative Example illustrated in FIG. **4**, an internal stress (stress ratio) to be generated changes as follows with an increase in the compression ratio as illustrated in FIGS. **5**A-**5**D.



FIG. **5**A/Compression ratio: 2.5

FIG. **5**B/Compression ratio: 6.0→Stress ratio in comparison with FIG. **5**A: 1.0

FIG. **5**C/Compression ratio: 11.0→Stress ratio in comparison with FIG. **5**A: 1.4

FIG. **5**D/Compression ratio: 18.9→Stress ratio in comparison with FIG. **5**A: 1.7

When brought into the state of FIG. **5**D, the internal stress to be generated reaches 170%. Therefore, the repetition thereof leads to a breakage of the diaphragm **41** in some cases.

It is an object of the present invention to enable the relaxation of an internal stress generated in a diaphragm even when the operation compression ratio of an accumulator increases, and thus suppress a breakage of the diaphragm and improve the durability of the diaphragm.

## SUMMARY

The accumulator of the present invention is provided with an accumulator housing, a flexible diaphragm provided inside the accumulator housing in such a manner as to divide inside the accumulator housing, and a stress relaxing member provided inside the accumulator housing and regulating a deformed attitude of the diaphragm deformed by the pressure fluctuation inside the accumulator housing by the contact of the diaphragm with the stress relaxing member.

### Effect of the Invention

According to the present invention, even when the operation compression ratio of the accumulator increases, the internal stress generated in the diaphragm can be relaxed, and therefore a breakage of the diaphragm can be suppressed and the durability of the diaphragm can be improved.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of an accumulator of an embodiment.

FIG. **2** is a cross-sectional view of an accumulator of another embodiment.

FIG. **3** is a cross-sectional view of an accumulator of the Background Art.

FIG. **4** is a cross-sectional view of an accumulator of a Comparative Example.

FIGS. **5**A-**5**D are explanatory views illustrating changes in a compression ratio and a stress ratio in the accumulator.

FIG. **6** is a graph illustrating comparison test results.

## DETAILED DESCRIPTION

An embodiment is described based on FIG. **1** and FIG. **2**. The same portions as or portions equivalent to those of the accumulators illustrated in FIG. **3** and FIG. **4** are designated by the same reference numerals.

FIG. **1** illustrates a cross-sectional view in which an accumulator **11** of the embodiment is partially cut. The accumulator **11** of the embodiment is a diaphragm accumulator in which a diaphragm **41** having flexibility is provided inside an accumulator housing **21**.

The accumulator **11** of the embodiment has the accumulator housing **21** provided with a gas filling opening **22** and an oil port **23**, in which the diaphragm **41** having flexibility is provided inside the accumulator housing **21**. The diaphragm **41** divides the internal space of the accumulator housing **21** into a gas filled chamber (gas chamber) **24** leading to the gas filling opening **22** and a fluid chamber (liquid room) **25** leading to the oil port **23**.

The accumulator housing **21** has a shell **26** formed by drawing of a metal component and the inner surface thereof has a combined shape of curved surfaces **27**, **28** having an arc-shaped cross-section. The curved surface formed on the inner surface of the housing **21** has a combination of the curved surface **27** on the gas filling opening side in a direction where the inner diameter dimension gradually enlarges from the gas filling opening **22** to the oil port **23** and the curved surface **28** on the oil port side in a direction where the inner diameter dimension gradually enlarges conversely from the oil port **23** to the gas filling opening **22**. The curved surface **28** on the oil port side is formed by drawing from a cylindrical surface.

In the maximum inner diameter portion of the shell **26**, an annular diaphragm holder **31** having a hook shape for holding the diaphragm **41** is provided. The diaphragm holder **31** integrally has a fixing portion **32** having an annular flat plate shape fixed to the inner surface of the accumulator housing **21** and a cylindrical hook **33** provided from the inner peripheral end of the fixing portion **32** to the oil port **23** side (lower side in the figure). The diaphragm holder **31** is formed into a hook shape having an L-shaped cross-section.

The diaphragm **41** is a resin or rubber laminated structure integrally having an outer peripheral attachment portion **42**, a flexible portion **43**, and a reversing portion **44**. The outer peripheral attachment portion **42** is held by the diaphragm holder **31** provided on the side inner surface of the accumulator housing **21**. The flexible portion **43** is deformed according to a pressure fluctuation inside the accumulator housing **21**. The reversing portion **44** is provided between the outer peripheral attachment portion **42** and the flexible portion **43** and integrally has a reversing portion having a substantially U-shaped cross-section deformed together with the flexible portion **43**. To the center of the plane of the flexible portion **43**, a poppet **45** for suppressing the protrusion of the diaphragm **41** to a through hole of the oil port **23** is attached. The diaphragm **41** is formed into a diaphragm having a shape of projecting to the gas filled chamber **24** side as a whole in order to cope with high compression. The diaphragm **41** is also referred to as a bladder.

The above-described configuration is basically the same configuration as that of the accumulator **11** of Comparative Example illustrated in FIG. **4**. When the operation compression ratio (=Operation pressure/Initial filling gas pressure) increases, the flexible portion **43** of the diaphragm **41** is greatly displaced to the gas filled chamber **24** side, so that the reversing degree of the reversing portion **44** increases at this time, whereby the reversing portion **44** is pressed against the inner peripheral surface of the diaphragm holder **31**. In the accumulator **11** illustrated in FIG. **4**, an overstress is generated in the reversing portion **44**. The repetition thereof leads to a breakage of the diaphragm **41** in some cases. This embodiment takes the following measure against the problem.

As illustrated in FIG. **1**, the accumulator **11** of this embodiment is provided with a stress relaxing member **51** reducing a stress generated in the diaphragm **41** on the inner surface of the accumulator housing **21**. Due to the fact that, when the flexible portion **43** of the diaphragm **41** is displaced to the gas filled chamber **24** side by a pressure fluctuation inside the accumulator housing **21**, the flexible portion **43** and the reversing portion **44** of the diaphragm **41** contact the stress relaxing member **51**, the stress relaxing member **51** regulates the deformed attitude of the flexible portion **43** and the reversing portion **44** to stop the deformation to thereby reduce the deformation amount.

The stress relaxing member **51** is disposed in the gas filled chamber **24**. The stress relaxing member **51** is disposed at a position ranging from the inner periphery of the diaphragm holder **31** to the inner periphery of the curved surface **27** on the gas filling opening **22** side (upper side in the figure) of the diaphragm holder **31** and on the gas filling opening side in the accumulator housing **21**. The stress relaxing member **51** is fixed to the diaphragm holder **31** and the accumulator housing **21**.

The stress relaxing member **51** is annularly formed of resin or rubber and integrally has a thin portion **52** disposed on the inner periphery of the diaphragm holder **31** and a thick portion **53** disposed on the inner periphery of the curved surface **27** on the gas filling opening **22** side of the diaphragm holder **31** and on the gas filling opening side in the accumulator housing **21**. The stress relaxing member **51** has an outer peripheral surface having a cylindrical surface shape contacting the inner peripheral surface of the hook **33** in the diaphragm holder **31**, an end surface having a planar shape perpendicular to the axis contacting the gas filling opening side end surface of the fixing portion **32** in the diaphragm holder **31**, an outer peripheral curved surface contacting the curved surface **27** on the gas filling opening side in the accumulator housing **21**, and further an inner peripheral surface. The inner peripheral surface is formed as an annular contact surface **55** which the diaphragm **41** separably contacts in deformation.

The contact surface **55** is formed into an inclined surface of a tapered shape in a direction where the inner diameter dimension gradually reduces as the contact surface **55** is away from the reversing portion **44** of the diaphragm **41** in the axial direction, i.e., from the oil port **23** side to the gas filling opening **22** side. The inclined surface may have a linear cross-section but is formed to have a convex arc-shaped cross-section in this embodiment.

The stress relaxing member **51** is formed into a shape imitating the deformation position of the diaphragm **41** as a whole (structure of being provided along the shell **26** and becoming thin toward the oil port side end of the diaphragm holder **31**). The stress relaxing member **51** is also referred to as a buffer member.

In the accumulator **11** having the above-described configuration, when the flexible portion **43** of the diaphragm **41** is displaced to the gas filled chamber **24** side by a pressure fluctuation inside the accumulator housing **21**, the flexible portion **43** and the reversing portion **44** of the diaphragm **41** contact the contact surface **55** of the stress relaxing member **51**. The deformed attitude of the flexible portion **43** and the reversing portion **44** is regulated by the contact, so that the deformation is stopped, whereby the deformation amount is reduced. As a result, the accumulator **11** can reduce the internal stress generated in the diaphragm **41**, suppress a breakage of the diaphragm **41**, and improve the durability of the diaphragm **41**.

When the accumulator (with the stress relaxing member) of this embodiment and the accumulator (with no stress relaxing member) of Comparative Example illustrated in FIG. **4** are compared, the internal stress (maximum stress) generated in the diaphragm **41** is smaller in the accumulator of this embodiment as illustrated in the graph of the comparison test results of FIG. **6**. Therefore, the effect by the stress relaxing member **51** is confirmed.

In the implementation, the contact surface **55** set as the inner peripheral surface of the stress relaxing member **51** is not formed into the inclined surface of the tapered shape in which the inner diameter dimension gradually reduces from the oil port **23** side to the gas filling opening **22** side as in this embodiment and can be formed into a cylindrical surface (straight surface in the axial direction) parallel to an accumulator center axis O. In this case, the internal stress (maximum stress) generated in the diaphragm **41** contrarily exceeds that of the accumulator (with no stress relaxing member) of Comparative Example illustrated in FIG. **4** in some cases. Therefore, it is preferable that the contact surface **55** set as the inner peripheral surface of the stress relaxing member **51** is formed into the inclined surface of the tapered shape as in this embodiment.

The inclined surface of the tapered shape may be set not on the entire surface but on only a part of the contact surface **55**. FIG. **2** illustrates an example in this case. The contact surface **55** is formed by a combination of a straight surface in the axial direction **56** at a position relatively close to the diaphragm **41** and an inclined surface **57** at a position relatively distant from the diaphragm **41**. In the inclined surface **57**, the inner diameter dimension gradually reduces as the inclined surface **57** is away from the diaphragm **41** in the axial direction, i.e., from the oil port **23** side to the gas filling opening **22** side. The inclined surface **57** may have a linear cross-section but is formed to have a concave arc-shaped cross-section in this embodiment. In the example illustrated in FIG. **2**, the oil port side end (lower end in the figure) of the stress relaxing member **51** projects to the oil port **23** side (lower side in the figure) relative to the oil port side end of the diaphragm holder **31**. A contact surface extension portion **58** having an arc-shaped cross-section is provided here. The diaphragm **41** contacts the contact surface **55** containing the contact surface extension portion **58**, the straight surface in the axial direction **56**, and the inclined surface **57**.

The invention claimed is:

**1**. An accumulator comprising:

an accumulator housing;

an annular diaphragm holder fixed to an interior surface of the accumulator housing;

a flexible diaphragm provided inside the accumulator housing in such a manner as to divide an inside of the accumulator housing, and end of the flexible diaphragm being sandwiched between the annular diaphragm holder and the interior surface of the accumulator housing; and

a resin or rubber stress relaxing member provided inside the accumulator housing and regulating a deformed attitude of the diaphragm deformed by a pressure fluctuation inside the accumulator housing by contact of the diaphragm with the stress relaxing member, the stress relaxing member including a first portion that extends along the annular diaphragm holder and a second portion that extends along the interior surface of the accumulator housing, and a contact surface of the stress relaxing member that is configured to contact the diaphragm and that connects the first portion to the second portion is convexly formed such that the contact surface protrudes in a direction toward an interior of the accumulator housing.

**2**. The accumulator according to claim **1**, wherein

an inner diameter dimension of the convexly formed contact surface gradually reduces as a distance between convexly formed contact surface and the diaphragm increases in an axial direction away from the diaphragm.

* * * * *